Demo: UI Based Attacks in WebXR

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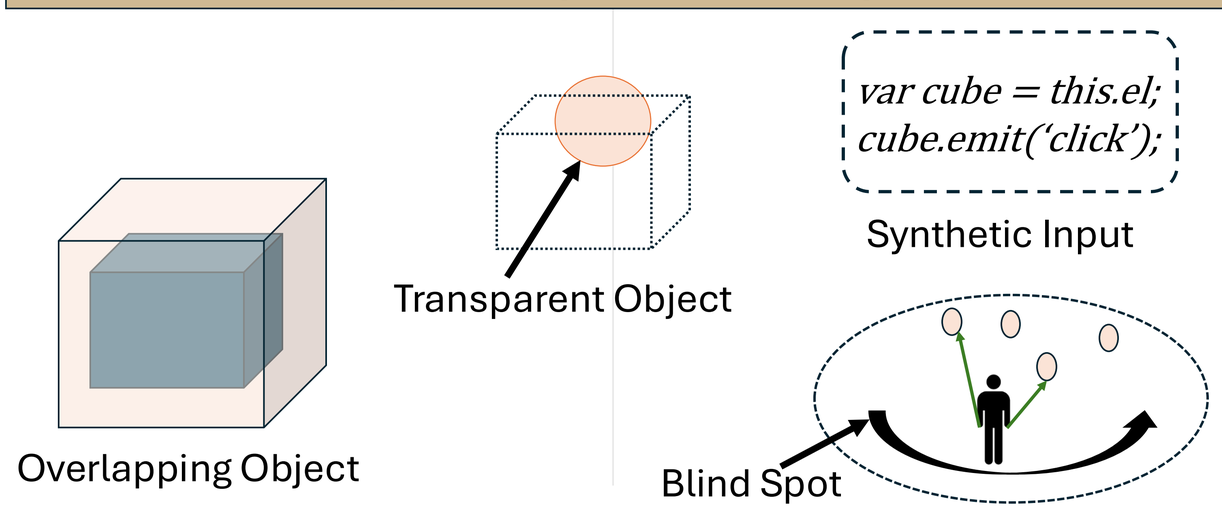
Background & Motivation

- **WebXR** enables immersive AR/VR experiences through browsers on head-mounted displays (HMDs).
- **Security-sensitive UI properties** (e.g., transparency, synthetic input) can be exploited for UI-based attacks [1,2,3].
- Unlike the standard web, **WebXR lacks <iframe>** like element that separates execution of different origins.
- Third-party entities, such as advertisements, **share the same scene** as other objects within the publisher's WebXR site.
- Our prior work [3] identifies **five novel UI-based attacks** in WebXR that exploit the advertising ecosystem.
- This demo integrates these attacks in a **gaming environment** into distinct interactive scenarios to show their effectiveness.

Example Of Exploitable UI Properties



Beneficial Use Cases

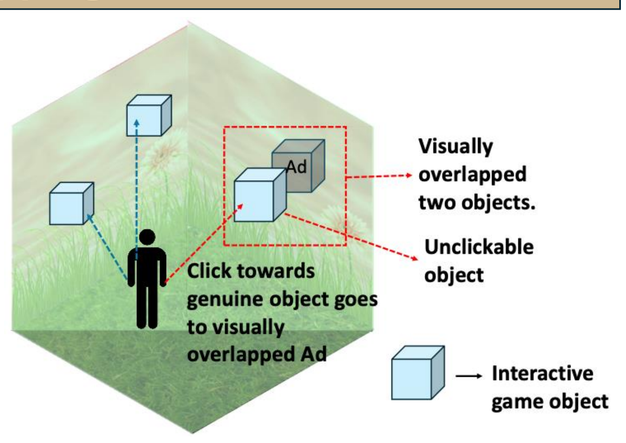
- Transparency creates visual effects (e.g., depth, flowing water, shattering glasses).
- Same place overlapping objects create complex scene with intricate architecture.
- Synthetic input can be used for dynamic object interaction.
- Auxiliary screen can be used by developers for debugging.
- Programmatic screenshot capture can be used for automated testing, media sharing etc.
- Gaze-fusing override provides faster and more precise interaction.

UI Based Attacks

- These UI properties can be exploited in WebXR advertising ecosystem.
- Advertiser, ad service provider, and developer - any of these entities can act as an adversary.
- These attacks compromise user autonomy, leading to data theft and malware downloads onto the user's system.
- Additionally, these attacks can cause financial or reputational damage to the ad stakeholders.

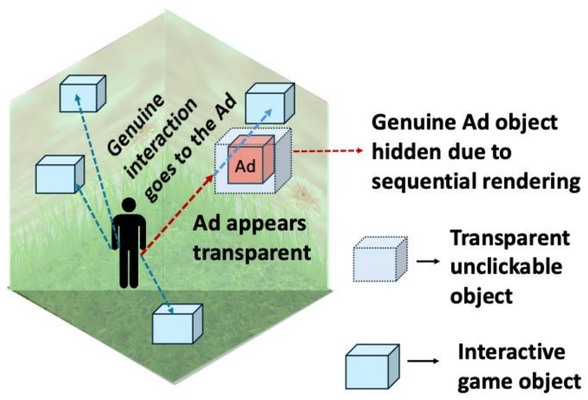
Visual Overlapping Attack

- **Exploited properties** - Synthetic input, click received by first clickable object
- **Adversary** – Developer
- **Goal** – Revenue from ad clicks
- **Malicious Impact on** – User, advertiser



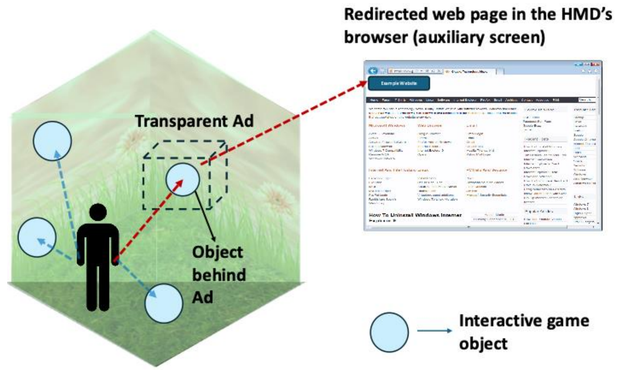
Sequential Rendering Attack

- **Exploited properties** – Transparency, same space overlapping objects, synthetic input, sequential rendering, click received by first clickable object
- **Adversary** – Developer
- **Goal** - Revenue from ad clicks
- **Malicious Impact on** – User, advertiser



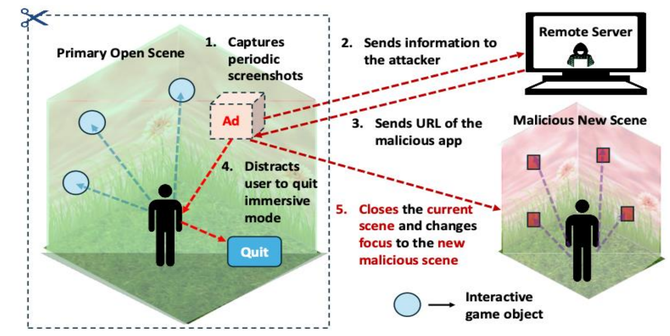
Malvertising Attack

- **Exploited properties** – Lack of iframe, transparency, scene entry/exit detection, click received by first clickable object, auxiliary screen
- **Adversary** – Advertiser
- **Goal** – Increase SEO ranking or video views
- **Malicious Impact on** – User, developer, ad service provider



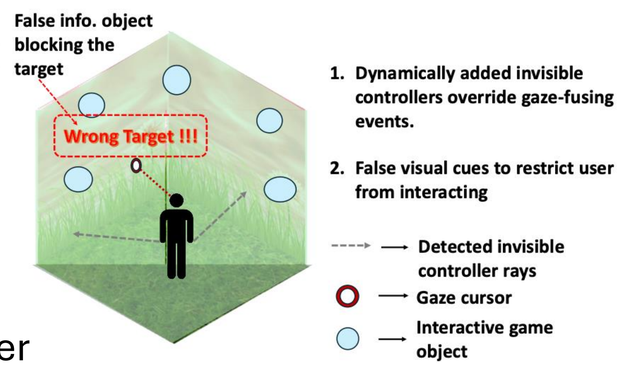
GUI Switch Attack

- **Exploited properties** – Lack of iframe, scene entry/exit detection, capturing programmatic screenshot
- **Adversary** – Advertiser
- **Goal** – Extracts user's private information
- **Malicious Impact on** – User



DoS Through Overriding Attack

- **Exploited properties** – Lack of iframe, transparency, gaze-fusing override
- **Adversary** – Competitive ad service provider
- **Goal** – Restrict user's intended action
- **Malicious Impact on** – User, other ad service provider, advertiser



Takeaways & Future Directions

- The UI properties can be exploited knowing or unknowingly, raising the risk for UI based attacks with integration of third-party objects.
- Critical need for user-centered design approaches that maintain action awareness in immersive environments.
- To investigate whether developers encounter challenges in integrating third-party objects into immersive scenes, and to identify those challenges.

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Survey QR Code

Please scan this QR code to participate in our follow-up survey.

References

[1] Hyunjoo Lee, Jiyeon Lee, Daejun Kim, Suman Jana, Insik Shin, and Sooel Son. 2021. AdCube: WebVR Ad Fraud and Practical Confinement of Third-Party Ads. In USENIX Security.

[2] Kaiming Cheng, Arkaprabha Bhattacharya, Michelle Lin, Jaewook Lee, Aroosh Kumar, Jeffery F. Tian, Tadayoshi Kohno, and Franziska Roesner. 2024. When the User Is Inside the User Interface: An Empirical Study of UI Security Properties in Augmented Reality. In USENIX Security.

[3] Chandrika Mukherjee, Reham Mohamed, Arjun Arunasalam, Habiba Farrukh, and Z. Berkay Celik. 2025. Shadowed Realities: An Investigation of UI Attacks in WebXR. In USENIX Security.